

***Recommended Grades:***

Intermediate Level (5-8).

***Objective:***

Use SAGE II data table information to create bar graphs.

***Prerequisite Skills:***

Students should know how to prepare a graph with titles, legends, labels, scales, x and y axes.

***Concept:***

Volcanoes, car exhaust, industrial plants, forest fires, and even ocean evaporation fill the Earth's atmosphere with not only gaseous pollutants, but also very small particles. These particles, which include dust, ash, spores, bacteria, viruses, ammonia, organic material, sea salt crystals, and sulfur and nitrogen compounds, clump together with gases and water in the atmosphere to form aerosols. Being so small, the particles are not usually visible. However, when these particles are sufficiently large, their presence is noticed as they scatter and absorb sunlight.

***Principles:***

1. Aerosols <<http://terra.nasa.gov/FactSheets/Aerosols/>> are solid or liquid particles found in the atmosphere. Aerosols impact the Earth's radiation balance <[http://eosweb.larc.nasa.gov/EDDOCS/Erb\\_Intro.html](http://eosweb.larc.nasa.gov/EDDOCS/Erb_Intro.html)> directly by scattering and absorbing incoming radiation from the sun (solar radiation). Students can shine a flashlight against a dark object, like a sheet of black construction paper, to view airborne particles (dust, hair, etc.) in the classroom.
2. Aerosol extinction is the reduction of incoming radiation through scattering and absorbing by the aerosols.
3. The Stratospheric Aerosol and Gas Experiment (SAGE) is a three generation project (SAGE I, II and III) focusing on the collection of data about aerosols in the stratosphere. Go to <[http://www-sage2.larc.nasa.gov/mission\\_status/](http://www-sage2.larc.nasa.gov/mission_status/)> to track the current position of the SAGE II instrument on board the ERBS spacecraft.
4. NASA's Total Ozone Mapping Spectrometer (TOMS) instrument detected the Mt. Pinatubo aerosol cloud from space. Go to <<http://earthobservatory.nasa.gov/Observatory/Datasets/ozone.toms.html>> to view TOMS data animations.

***Applicable National Standards:***

Science, Level 5-8:

- Standard A, "Science as Inquiry"
- Standard E, "Science and Technology"

Mathematics, Level 5-8:

- Standard 3.2 (Understanding & applying reasoning to proportions and graphs)
- Standard 10.2 (Constructing, reading, and interpreting tables, charts and graphs)

**\* Please note that all links provided within this lesson are found at the end of the page.**

***Activity Procedures:***

1. Students should read the NASA Facts: Earth's Stratosphere  
<<http://oea.larc.nasa.gov/PAIS/SAGE.html>> and Atmospheric Aerosols  
<<http://oea.larc.nasa.gov/PAIS/Aerosols.html>> to better understand the data they will plot.
2. Review the basic features of a graph with titles, legends, labels, scales, x and y axes. Bar graphs are an excellent way to compare results.
3. Go to the SAGE II web site, scroll mid-page to the Season and Data Product Table. Select a season and time coverage:  
<<http://www-sage2.larc.nasa.gov/data/aerosol/tropospheric/>>.
4. A data table will be generated like the one shown below.

Alt(km)	Extinction (1/km) x 1E-04						mar1988-may1988	
	80s-60s	60s-40s	40s-20s	20s-Eq	Eq-20n	20n-40n	40n-60n	60n-80n
6.5	3.2	2.1	2.1	3.0	3.4	6.2	14.3	13.0
7.5	4.0	2.5	1.8	2.4	4.0	6.1	11.5	10.5
8.5	4.9	2.6	1.6	2.4	2.8	5.3	10.0	9.6
9.5	4.3	2.8	1.6	1.9	2.0	4.9	8.2	8.7
10.5	3.3	2.8	1.8	1.5	2.0	4.9	7.6	7.4
11.5	2.9	2.9	1.9	1.4	2.1	3.9	6.3	6.3
12.5	3.0	2.8	1.8	1.5	1.8	3.3	4.9	5.3
13.5	3.2	2.6	1.7	1.5	1.8	2.6	4.0	4.6
14.5	3.7	2.7	1.6	1.6	1.8	2.3	3.6	4.0
15.5	3.8	3.0	1.6	2.0	1.8	2.2	3.4	3.5
16.5	3.8	3.4	1.8	1.4	1.6	2.2	3.2	3.0
17.5	3.5	3.5	2.2	1.6	1.7	2.4	3.0	2.4
18.5	3.2	3.4	2.8	2.0	2.1	2.7	2.5	1.8
19.5	2.5	2.9	3.1	2.8	2.8	2.7	1.9	1.2
20.5	1.8	2.3	3.0	3.4	3.2	2.2	1.3	0.8
21.5	1.1	1.7	2.5	3.5	3.1	1.6	0.8	0.5
22.5	0.6	1.2	2.0	3.3	2.7	0.9	0.5	0.4
23.5	0.4	0.8	1.6	2.8	2.2	0.6	0.4	0.3
24.5	0.2	0.5	1.1	2.3	1.7	0.4	0.3	0.2
25.5	0.1	0.3	0.8	1.8	1.5	0.3	0.2	0.2

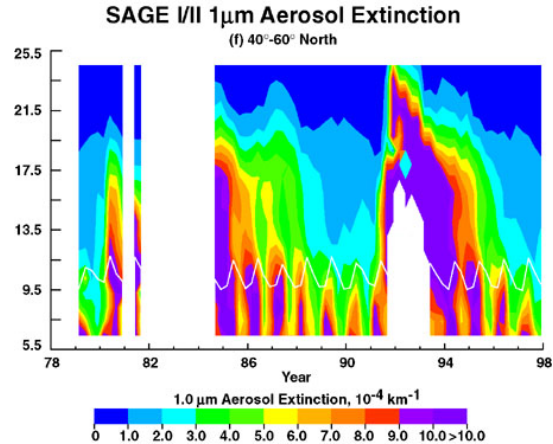
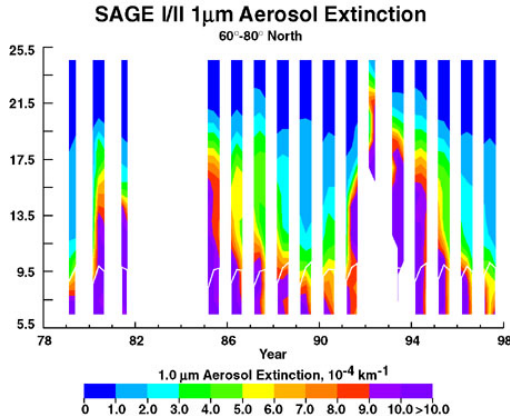
5. Print the data table results.
6. On the print out, duplicate the scale under the data table.



7. Construct the bar graph under the scale. Write the range of altitude on the y axis (5.5 km – 25.5 km). On the x axis, write the latitude ranges (80s-60s to 60n-80n).
8. Use the scale to color the aerosol level at each designated altitude.
9. The bar graph should depict a global representation for one year. The colors indicate the level of aerosol extinction. The higher the number, the thicker the aerosol layer, thus preventing solar radiation from reaching the Earth's surface. Please visit [http://eosweb.larc.nasa.gov/EDDOCS/Erb\\_Intro.html](http://eosweb.larc.nasa.gov/EDDOCS/Erb_Intro.html) for more information about solar radiation.

### ***Evaluation:***

1. After completing the graph, the student should be able to compare the aerosol levels among the range of altitudes; explain how to read a data table and construct a bar graph; interpret the colors used in the graph; and understand the impact aerosols have on the Earth.
2. Unlike the one year global depiction the students will complete, the following examples are 10 year global depictions of aerosol extinction. These examples are intended to serve as a finished product model.



- The images show the variability of aerosol extinction by height (y axis: 5.5 km - 25.5 km) and time (1978 – 1998).
- The gaps within the graphs indicate that data were not collected at that time.

***NASA Extension Activities:***

1. The Particulate Sampler activity illustrates the quantitative measurement of the particulate pollution present in the students' neighborhoods and their school locations. <[http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm\\_filter.html](http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm_filter.html)>
2. The Atmospheric Filter activity demonstrates how the components of Earth's atmosphere absorb or distort incoming radiation.  
<[http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm\\_filter.html](http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm_filter.html)>
3. Graph ozone concentration and temperature data by accessing the following web sites:
  - TOMS – Ozone Spectrometer Graphing Activity  
[http://www.exploratorium.edu/learning\\_studio/ozone/chemistry.html](http://www.exploratorium.edu/learning_studio/ozone/chemistry.html)
  - S'COOL – Graphing Temperature Data  
[http://asd-www.larc.nasa.gov/SCOOL/lesson\\_plans/Graphing\\_Grade\\_7.html](http://asd-www.larc.nasa.gov/SCOOL/lesson_plans/Graphing_Grade_7.html)

***\*Links within the lesson available over the WWW:***

Aerosol Facts:

<http://terra.nasa.gov/FactSheets/Aerosols/>

Atmospheric Aerosol Fact Sheet:

<http://oea.larc.nasa.gov/PAIS/Aerosols.html>

Atmospheric Filter Activity:

[http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm\\_filter.html](http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm_filter.html)

Earth Radiation Budget:

[http://eosweb.larc.nasa.gov/EDDOCS/Erb\\_Intro.html](http://eosweb.larc.nasa.gov/EDDOCS/Erb_Intro.html)

Earth's Stratosphere Fact Sheet:

<http://oea.larc.nasa.gov/PAIS/SAGE.html>

Particulate Sampler Activity:

[http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm\\_filter.html](http://asd-www.larc.nasa.gov/Outreach/greenhouse/atm_filter.html)

SAGE I: <http://www-sage1.larc.nasa.gov/>

SAGE II: <http://www-sage2.larc.nasa.gov/>

SAGE II Mission Status:

[http://www-sage2.larc.nasa.gov/mission\\_status/](http://www-sage2.larc.nasa.gov/mission_status/)

SAGE II Tropospheric Aerosol Data Products:

<http://www-sage2.larc.nasa.gov/data/aerosol/tropospheric/>

SAGE III: <http://www-sage3.larc.nasa.gov/>

S'COOL Temperature Graphing Activity:

[http://asd-www.larc.nasa.gov/SCOOL/lesson\\_plans/Graphing\\_Grade\\_7.html](http://asd-www.larc.nasa.gov/SCOOL/lesson_plans/Graphing_Grade_7.html)

TOMS Data & Images:

<http://earthobservatory.nasa.gov/Observatory/Datasets/ozone.toms.html>

TOMS Ozone Spectrometer Graphing Activity:

[http://www.exploratorium.edu/learning\\_studio/ozone/chemistry.html](http://www.exploratorium.edu/learning_studio/ozone/chemistry.html)